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GB 0755004
GB 0349438
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(71) Applicant
David Brown Gear Industries Limited (Great Britain), Park Gear Works, Huddersfield, West Yorkshire
(72) Inventor
Robert Andrew Ashfield
(74) Agent and/or Address for Service
K. A. Norcliffe, 33 Delph Lane, Netherton, Huddersfield, West Yorkshire HD4 7JA

(54) **Multi-ratio gearbox**

(57) In a multi-ratio gearbox, for vehicles, having two contemporaneously operative layshafts, the sharing of the torque in equal or predeterminedly unequal proportions between the layshafts is achieved by interposing a suitable differential unit 31 between an input shaft 30 and the layshafts 32, 33. Where each of a plurality of gears 35, 36 and 37 fixed to an output shaft 34 meshes with two identical gears 38 and 39, 40 and 41 or 42 and 43 rotateable on and individually clutchable to the respective layshafts 32 and 33, the overall gear ratios are arranged in a geometric progression by arranging that the layshaft to output shaft gear ratios are arranged in the square of the common ratio of said progression, that the layshafts' clutch operating sequence connects the output shaft 34 contemporaneously either to both layshafts 32 and 33 through any one of the output shaft's gears 35, 36 and 37 or to the respective layshafts 32 and 33 through any two of said gears which are consecutively sized, and that the differential unit 31 shares the torque between the layshafts 32 and 33 in said common ratio.

The gearing on the respective layshafts 31, 32 may be different such that the torque is shared equally between the layshafts.

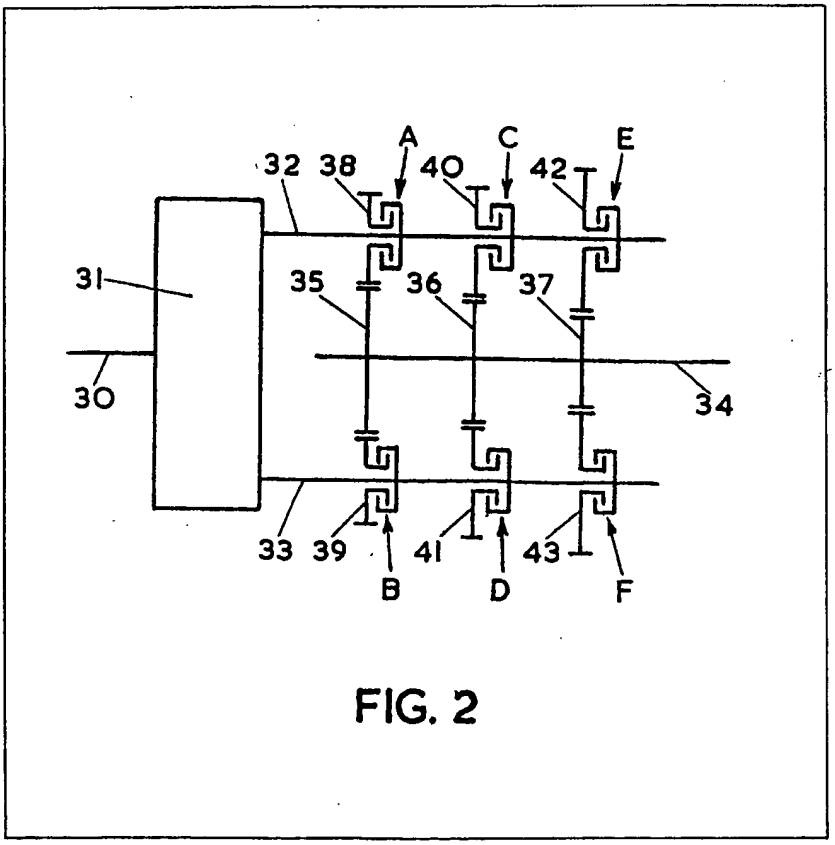

FIG. 2

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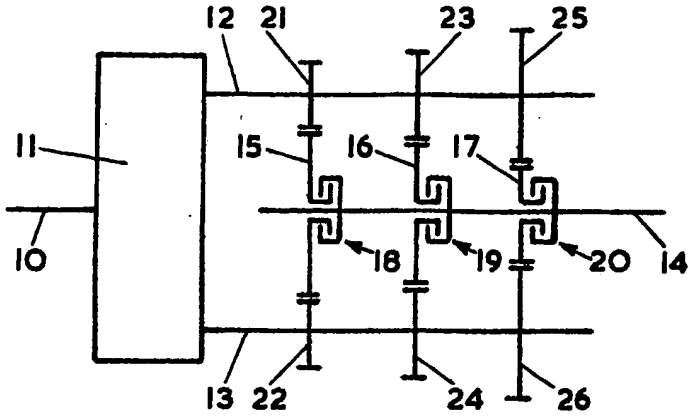
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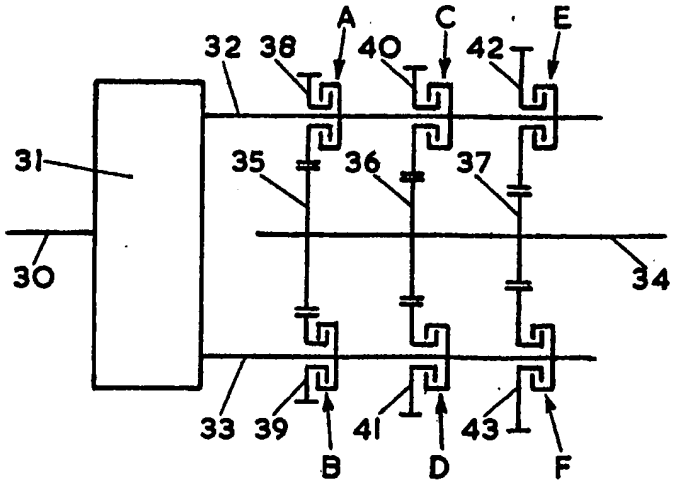
26

FIG. 1


A
C
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32
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30
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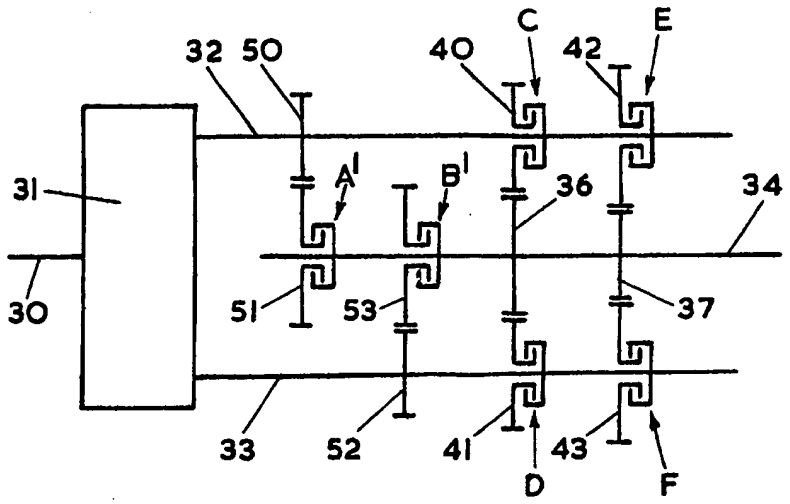
43
B
D
F

FIG. 2


32
50
40
C
42
E
31
A'
B'
36
34
30
51
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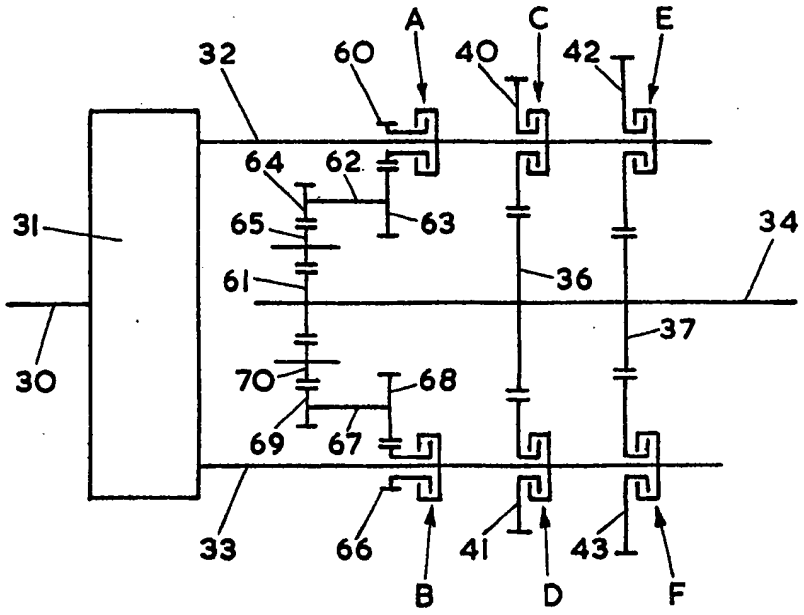
37
33
52
41
43
D
F

FIG. 3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60
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42
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62
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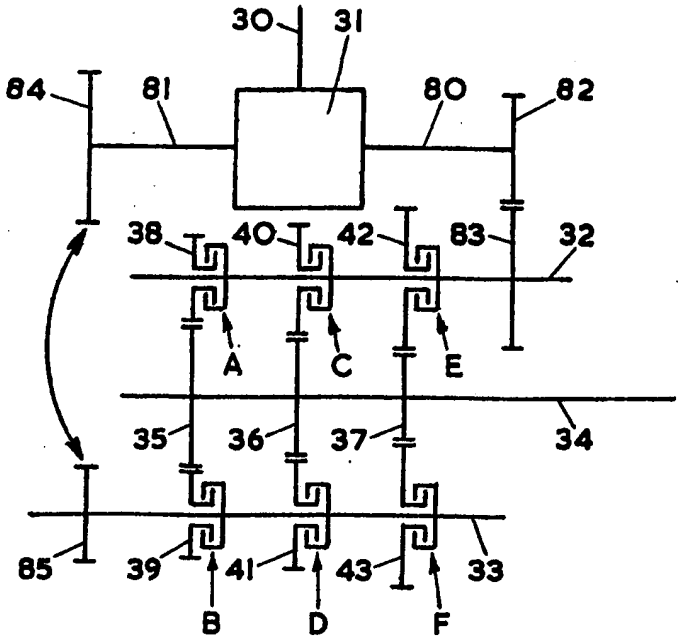
69
67
33
66
41
43
B
D
F

FIG. 4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82
38
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83
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C
E
35
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41
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33
B
D
F

FIG. 5

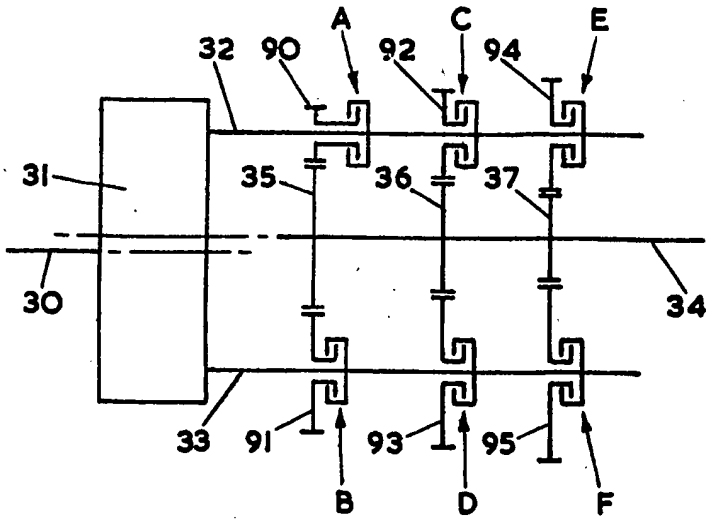
A
C
E
32
90
92
94
31
35
36
37
30
34
33
91
93
95
B
D
F

FIG. 6

SPECIFICATION
Multi-ratio gearbox

This invention relates to a multi-ratio gearbox particularly for vehicles.

The object of the invention is to share the torque between two contemporaneously operative layshafts in a novel and advantageous manner.

According to one aspect of the invention, a multi-ratio gearbox comprises two layshafts constituting or driven by the respective outputs of a differential unit.

According to another aspect of the invention, a multi-ratio gearbox comprises an input shaft, a differential unit the input of which is constituted by said shaft, two layshafts constituting or driven by respective outputs of said unit, and an output shaft capable of being selectively driveably connected contemporaneously to each layshaft through one of a plurality of power paths.

Two embodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings of which:—

Fig. 1 shows a three-speed gearbox;

Fig. 2 shows a five-speed gearbox;

Fig. 3 shows a first modification of the gearbox of Fig. 2;

Fig. 4 shows a second modification of the gearbox of Fig. 2;

Fig. 5 shows a third modification of the gearbox of Fig.2; and

Fig. 6 shows a fourth modification of the gearbox of Fig. 2.

Referring now to Fig. 1, a three-speed gearbox comprises an input shaft 10 adapted to be driven by an engine (not shown) through a clutch or the like (not shown) and constituting the input of any suitable form of differential unit 11, twin layshafts 12 and 13 constituting the respective outputs of said unit, and an output shaft 14 parallel to and equally spaced from the layshafts 12 and 13. Three gears 15, 16 and 17 having different pitch circle diameters are rotateably mounted on the output shaft 14 and are capable of being alternatively driveably connected thereto by respective clutches 18, 19 and 20. The gear 14 meshes constantly with two identical gears 21 and 22 fixed to the respective layshafts 12 and 13, the gear 16 meshes constantly with two identical gears 23 and 24 fixed to the respective layshafts 12 and 13, and the gear 17 meshes constantly with two identical gears 25 and 26 fixed to the respective layshafts 12 and 13. Throughout this specification, the expression "fixed to" is intended to denote "rigidly secured on or integral with". The differential unit 11 is designed to share the torque equally between the layshafts 12 and 13. The aforesaid pitch circle diameters may conveniently be so chosen that the three gear ratios capable of being transmitted by the gearbox are arranged as nearly as possible in a geometric progression, a, ar, ar^2, ar^3, etc. having regard to the need to provide each gear with a whole number of teeth. This gearbox is non-preferred because, as will next be described, additional speeds can be obtained without increasing the number of gears employed.

Referring now to Fig 2, a preferred five-speed gearbox comprises an input shaft 30 adapted to be driven by an engine (not shown) through a clutch or the like (not shown) and constituting the input of any suitable form of differential unit 31, twin layshafts 32 and 33 constituting the respective output of said unit, and an output shaft 34 parallel to and equally spaced from the layshafts 32 and 33. Three gears 35, 36 and 37 having different pitch circle diameters are fixed to the output shaft 34. The largest gear 35 on the output shaft 34 meshes constantly with two identical gears 38 and 39 which are rotateably mounted on the respective layshafts 32 and 33 and are capable of being individually driveably connected thereto by respective clutches A and B, the intermediate sized gear 36 on the output shaft 34 meshes constantly with two identical gears 40 and 41 which are rotateably mounted on the respective layshafts 32 and 33 and are capable of being individually driveably connected thereto by respective clutches C and D, and the smallets gear 37 on the output shaft 34 meshes constantly with two identical gears 42 and 43 which are rotatably mounted on the respective layshafts 32 and 33 and are capable of being individually driveably connected thereto by respective clutches E and F. The clutch engagement sequence required to change consecutively from first (low) through second, third, and fourth to fifth (high) gear is AB, BC, CD, DE and EF. However, if the differential unit 31 were to share the torque equally between the layshafts 32 and 33 the five overall gear ratios capable of being transmitted by the gearbox could not be in geometric progression. To achieve such a progression, the layshaft to output shaft gear ratios are arranged as nearly as possible in the square of the common ratio r of said progression, and the differential unit 31 is designed to share the torque between the layshafts 32 and 33 as nearly as possible in the common ratio r of said progression. It will be apparent that additional overall gear ratios can be obtained simply by providing further appropriately sized gears and associated clutches. For example, a total of seven overall gear ratios is obtainable by adding three gears and two clutches.

Referring now to Fig. 3, in which parts in common with Fig. 2 are indicated by the same reference numerals, the gearbox of Fig. 2 is so modified that the lowest overall gear ratio is transmitted contemporaneously from a gear 50 fixed to the layshaft 32 and meshing with a gear 51 rotateably mounted on the output shaft 34 and capable of being driveably connected thereto by a clutch A^1 and from a gear 52 fixed to the layshaft 33 and meshing with a gear 53 rotateably mounted on the output shaft 34 and capable of being driveably connected thereto by a clutch B^1, the gears 51 and 53 constituting an identical duo. By disposing at least the lowest overall gear ratio clutches A^1 and B^1 on the output shaft 34, the first modification avoids excessively high relative

speeds between the layshafts and declutched gears rotateably mounted thereon in cases where the overall gear ratio spread is large.

Referring now to Fig. 4, in which parts in common with Fig. 2 are indicated by the same reference numerals, the gearbox of Fig. 2 is so modified that the lowest overall gear ratio is transmitted contemporaneously from a gear 60 on the layshaft 32 to a gear 61 fixed to the output shaft 34 by way of a double reduction gear system comprising a short countershaft 62 to which there are fixed two gears 63 and 64 meshing respectively with the gear 60 and with an idler gear 65 which meshes with the gear 61, and from a gear 66 on the layshaft 33 to the gear 61 by way of a double reduction gear system identical to the system 62, 63, 64, 65 and comprising a short counter-shaft 67 to which there are fixed two gears 68 and 69 meshing respectively with the gear 66 and with an idler gear 70 which meshes with the gear 61. This second modification avoids an excessively large centre-distance between each of the layshafts 32 and 33 and the output shaft 34 in cases where the lowest layshaft to output shaft gear ratio is required to be large. This second modification can be employed independently of the first modification shown in Fig. 3, or together therewith by substituting for the gear 61 fixed to the output shaft 34 a duo of identical gears meshing respectively in different planes with the idler gears 65 and 70 and capable of being individually driveably connected to said shaft by respective clutches, the gears 60 and 66 being fixed to the respective layshafts 32 and 33.

Referring now to Fig. 5, in which parts in common with Fig. 2 are indicated by the same reference numerals, the gearbox of Fig. 2 is so modified that the differential unit 31 is designed to share the torque equally between two shafts 80 and 81 constituting its respective outputs and said shafts drive the respective layshafts 32 and 33 by way of two gear pairs 82, 83 and 84, 85 of different ratios whose inter-relationship is arranged as nearly as possible in the common ratio r of the afore-mentioned geometric progression. This third modification can be employed either independently of or together with either or both of the first and second modifications shown respectively in Figs. 3 and 4.

Referring now to Fig. 6, in which parts in common with Fig. 2 are indicated by the same reference numerals, the gearbox of Fig. 2 is so modified that the differential unit 31 is designed to share the torque equally between the two layshafts 32 and 33 and the two centre-distances between the respective layshafts and the output shaft 34 are arranged to differ whereby the gear 35 fixed to the output shaft 34 meshes with two unidentical gears 90 and 91 on the respective layshafts 32 and 33, the gear 36 fixed to the output shaft 34 meshes with two unidentical gears 92 and 93 on the respective layshafts 32 and 33, and the gear 37 fixed to the output shaft 34 meshes with two unidentical gears 94 and 95 on the respective layshafts 32 and 33. The respective pitch circle diameters of the two unidentical gears 90 and 91, of the two unidentical gears 92 and 93 and of the two unidentical gears 94 and 95 are arranged to differ as nearly as possible in the common ratio r of the afore-mentioned geometric progression. This fourth modification can be employed either independently of or together with either or both of the first and second modifications shown respectively in Figs. 3 and 4, but not together with the third modification shown in Fig. 5 to which it is an alternative.

CLAIMS

1. A multi-ratio gearbox comprising two layshafts constituting or driven by the respective outputs of a differential unit

2. A multi-ratio gearbox comprising an input shaft, a differential unit the input of which is constituted by said shaft, two layshafts constituting or driven by the respective outputs of said shaft, two layshafts constituting or driven by the respective outputs of said unit, and an output shaft capable of being selectively driveably connected contemporaneously to each layshaft through one of a plurality of power paths.

3. A multi-ratio gearbox according to claim 2, wherein each one of a plurality of gears which are rotateably mounted on the output shaft and are capable of being alternatively clutched thereto meshes with two identical gears fixed to the respective layshafts, the differential unit sharing the torque equally between the two layshafts.

4. A multi-ratio gearbox according to claim 2, wherein each one of a plurality of gears which are fixed to the output shaft meshes with two identical gears which are rotateably mounted on the respective layshafts and are capable of being individually clutched thereto, the overall gear ratios being arranged as nearly as possible in a goemetric progression by arranging that the layshaft to output shaft gear ratios are arranged as nearly as possible in the square of the ratio of said geometric progression; that the clutches on the lay-shafts are operated in such a sequence that the output shaft is driveably connected contemporaneously either to both layshafts through any one of the gears fixed to the output shaft or to the respective layshafts through any two of said gears which provide consecutive layshaft through any two of said gears which provide consecutive layshaft to output shaft gear ratios; and that the differential unit shares the torque between the two layshafts as nearly as possible in the common ratio of said geometric prorgession.

5. A multi-ratio gearbox according to claim 4, so modified that at least the lowest overall gear ratio is transmitted contemporaneously from a gear fixed to one of the layshafts and meshing with a first gear rotatably mounted on the output shaft and capable of being clutched thereto and from a gear fixed to the other of the layshafts and meshing with a second gear rotateably mounted on the output shaft and capable of being clutched

thereto, said first and second gears constituting an identical duo.

6. A multi-ratio gearbox according to claim 4 or claim 5, so modified that at least the lowest overall gear ratio is transmitted contemporaneously from the two layshafts to the output shaft by way of respective double reduction gear systems.

7. A multi-ratio gearbox according to any one of claims 4 to 6, so modified that the differential unit shares the torque equally between its two outputs and said outputs drive the respective layshafts by way of two gear systems of different ratios whose inter-relationship is arranged as nearly as possible in the common ratio of the aforesaid geometric progression.

8. A multi-ratio gearbox according to any one of claims 4 to 6, so modifled that the differential unit shares the torque equally between the two layshafts and the two centre-distances between the respective layshafts and the output shaft are arranged to differ whereby each gear, or duo of identical gears. on the output shaft meshes with two unidentical gears on the respective layshafts, the respective pitch cicle diameters of said two unidentical gears differing as nearly as possible in the common ratio of the geometric progression.

9. A multi-ratio gearbox constructed, arranged and adapted to operate substantially as hereinbefore described with reference to, and as illustrated by, any one of Figs. 1 to 6 of the accompanying drawings.

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